JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

November 22, 2004

TO: G. Burke

FROM: A. Andujo/J. Retana

SUBJECT: Ulysses 18 Hours per day Support Feasibility Study

As requested by NASA Headquarters, RAPSO has completed a special study to analyze the ability of the DSN to support the Ulysses mission with 18 hours per day during the time period of March through April of 2005. (Weeks 09 – 17, 2005)

Background

Ulysses (ULYS) is requesting its Gamma Ray Burst (GRB) instrument and heater to be turned on for a period of two months from March through April 2005 to perform cross-calibrations with the GRB instrument on the SWIFT spacecraft. The SWIFT spacecraft is scheduled launch on November 20th of 2004. These calibrations are extremely important for the GRB science community and GRB data from ULYS is considered the baseline for pinpointing the source of gamma ray bursts.

Currently the Ulysses instrument power-sharing plan has the GRB instrument off for all of 2005 and the power/thermal studies performed by the Ulysses engineering team shows that there is not a acceptable trade which can be made with other instruments and subsystems which would not result in a high risk of hydrazine freezing. One option that has been identified is to switch off the on-board tape recorder which frees up enough power to allow the hydrazine heaters to operate and prevent hydrazine freezing, but the reduced tracking time necessary for real-time data playback would result in unacceptably large data gaps for the rest of the Ulysses science community. Therefore a request to explore the possibility of acquiring additional tracking time to minimize data outages was developed.

NASA headquarters has provided a red-line direction to this request. They have asked the Ulysses project to plan to activate the GRB instrument on or about March 1, 2005 for approximately two months.

There are two reasons for pinpointing the March 1st date to turn on the GRB instrument: First the date would allow SWIFT to perform its own instrument validation and if the validation proves successful then Ulysses would not be required for calibration. Secondly, NASA headquarters already identified the December through February a highly contentious period due to the Cassini/Huygens Probe Release activities, Deep Impact early checkouts, the Earth approach and swingby by Rosetta, all occurring in approximately the same right ascension as Ulysses.

This study focuses on determining the feasibility of providing 18 hour per day DSN support for the ULYS mission during the two month period required in support of SWIFT GRB calibration, as well as to identify schedule conflicts that are created by the increased requirement.

Summary

A visual inspection of the current mid-range schedule and the "what-if" schedule increasing Ulysses support to 18 hour per day confirms that ULYS could not receive 18 hour per day coverage during the analysis period without severely impacting many users of the DSN. In order for ULYS to gain the additional support outside of the existing gaps already available, would require extensive renegotiation and would impact other prime missions.

Assumptions

- Period of analysis is March through April of 2005, schedule weeks 09 – 17of 2005.
- S-band uplink capability is unavailable at Madrid beginning in 2005.
- DSS-15 is down in week 17 for Microwave Switch Controller Replacement
- DSS-34 is down in week 07 through 14 for X/X-Ka band installation
- DSS-65 is down in week 05 through 26 for Antenna Controller Replacement
- SOHO is in their keyhole period in weeks 09 through 14
- GOES-N Launch is scheduled for week 12
- NOAA-N launch is scheduled for week 10
- The chart showing the major events/downtimes occurring during this period and assumed for this study is attached.

Analysis

Analysis was accomplished using the FASTER (forecasting and scheduling tool for earth-based resources) forecasting system and the updated mission set database from the August 2004 Resource Allocation Review Board (RARB), the TIGRAS scheduling tool and currently developed schedules from the DSN Mid-Range process.

The study period under consideration has nearly fully been negotiated in the mid-range process with the exception of the GOES-N and NOAA-N launch supports.

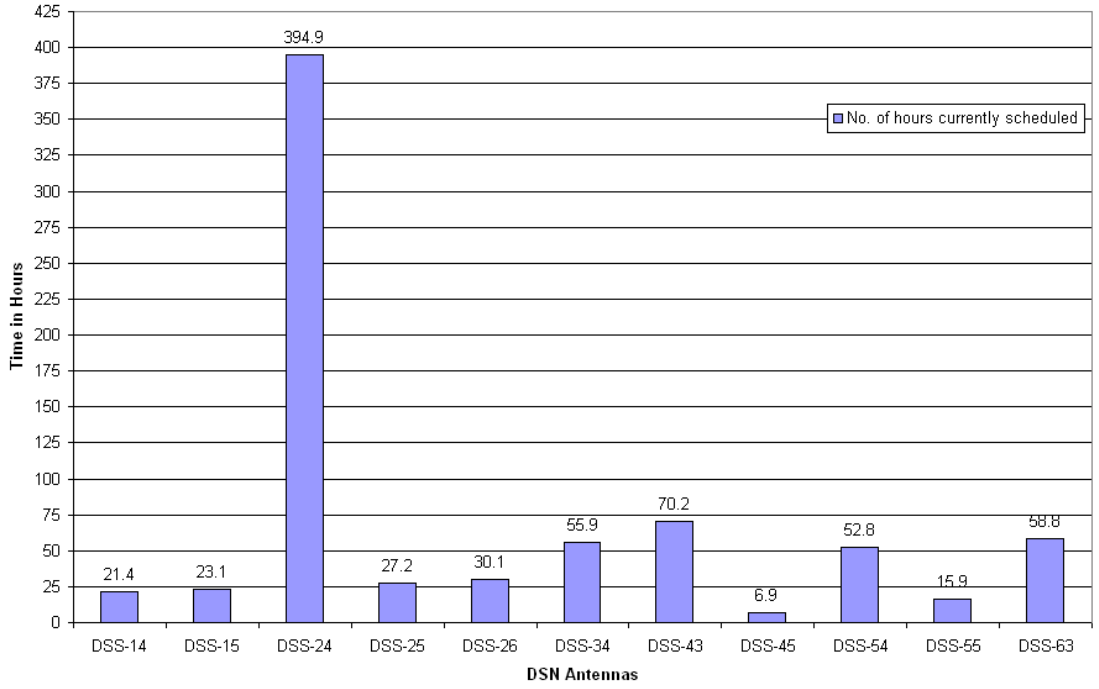
Figure 1 shows the number of hours requested at several of the Deep Space Network (DSN) antennas in the current schedule. Table-1 shows current ULYS contention existing with other missions at various antennas.

Table 1: Missions in contention with Ulysses

DSS-14	DSS-24	DSS-25	DSS-26	DSS-43	DSS-54	DSS-55	DSS-63
DSS (083) SOHO (083)	SOHO (085) SOHO (086) SOHO (105) VGR1 (118)	DIF (078)	STF (082)	STF (098) STF (112) GBRA (114) M01O (114) MGS (114)	VGR1 (078)	DIF (069)	GBRA (111) MEX (111) MER1 (112) VGR1 (112)

The numbers in "( )" indicate the day of year (DOY) the conflict with Ulysses exists.

Figure1: ULYS Current Schedule Hours in Weeks 09 - 17 2005



Currently, ULYS has 642 hours scheduled (without pre & post calibrations) for the entire duration. In order for the mission to gain 18 hour per day coverage for 61 days, it needs 1098 hours (61*18). In the 61 days assessed there are 46 gaps (that do not overlap with tracks already scheduled) of greater than four hours that could be used by Ulysses. If these 300 hours supported downlink only, the overhead of teardown and setup time is about 34.5 hours. Therefore Ulysses would need to negotiate an additional 190 hours, an average of 3 hours per day, from other missions already scheduled support to fulfill the requested 18 hours per day. [190.5 = 1098 – (642 + (300 - 34.5))] A list of gaps (greater than 4 hours) available in the current schedules which can be used by ULYS to request additional support is attached. It is important to note that many of the gaps available are at antennas that can only support Ulysses with downlink only. (See Table 3)

In order to assess the impact that ULYS would have with other missions when requesting 18 hours per day coverage, the current ULYS supports were either extended or modified and additional new supports were added on a best fit basis during this period to build a “what-if” schedule”. Also, in creating a “what-if” schedule, special effort was made to schedule ULYS supports so as to avoid contention with missions such as Rosetta (ROSE) during Earth swingby, MESSENGER (MSGR) during the Gamma Ray Spectrometer (GRS) cooler maneuver. (See Figure 3 DSN Downtime and Major Events)

NOAA-N and GOES-N may launch on March 10 and March 27, 2005 respectively and will request DSN 26 or 34 meter subnet support. As a result of the heavy loading on the whole network, specifically the 26 meter subnet, some missions that use the 26 meter subnet would have to move to the 34 meter or 70 meter subnet resulting in increased contention with ULYS supports.

Through a visual inspection of the current schedule, it is seen that ULYS cannot obtain 18 hour per day coverage without renegotiating and severely impacting other missions.

If the ULYS mission were to attempt this there are several factors that need to be considered:

- Resources down in this period need to return to service as planned
- Cooperation from most users must be attained
- NASA HQ direction for this effort
- The gaps identified would allow Downlink only support
- The 18 hours in a day will most likely never be contiguous
- In some cases up to 5 passes may need to be scheduled in a day resulting in several hours of setup and teardown time daily
- Both NOAA-N and GOES-N can find satisfactory time on the 26 meter subnet
- No emergencies or significant increases in requirements by prime users

Figure 2 shows the number of hours requested by ULYS and the allocation at various DSN antennas in a "what-if" schedule during this period.

Figure 2: ULYS "what-if" Schedule with 18-Hour coverage in weeks 09 - 17 of 2005

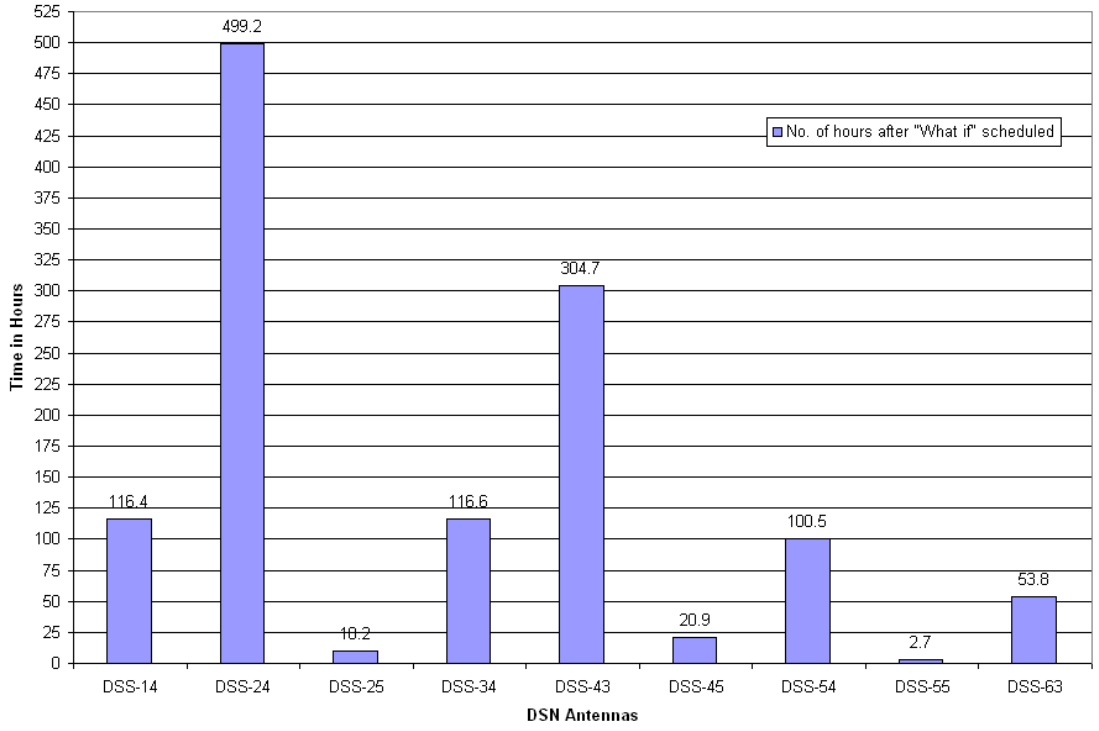


Table 2: Tracks in Conflict with Ulysses per Mission per Antenna

PROJ	DSS-14	DSS-24	DSS-25	DSS-34	DSS-43	DSS-45	DSS-54	DSS-63	Grand Total
ACE							1		1
ATOT	5				2				7
CHDR		28		3			9		40
CLU1		1		2	6				9
CLU2				1	1				2
CLU3		2		1					3
CLU4	1	1			1				3
DIF		1			5	1	4	3	14
DSN	2	4		1	2		1	1	11
DSS	2	5		1				1	9
GBRA	2				5			6	13
GSSR	5								5
GTL					1			1	2
IMAG		2		17		1			20
M01O	6				26		1		33
MAP	3				24			3	30
MER1			1		11				12
MER2	1				5				6
MEX	4				1				5
MGS			1		27				28
MSGR		2		1			3		6
POLR							2		2
ROSE		1							1
SOHO		8			1		2	5	16
STF		1			1		12	9	23
VGR1	2	8					1		11
VGR2				1	15	3			19
WIND		4					11		15
Grand Total	33	68	2	28	134	5	47	29	346

Table 2 shows the number of tracks where Ulysses is in conflict with a specific mission at a specific DSN antenna using the "what-if" schedule. It also shows the number of renegotiations that would be necessary for ULYS to get continuous coverage. A sample schedule showing the current schedule and a "what-if" schedule requesting 24-hour coverage for ULYS is attached at the end of the study.

Conclusion

It can be safely stated that ULYS cannot easily obtain this increased coverage during the requested time period from March through April 2005. If ULYS utilizes the available gaps many supports will be downlink only and may not allow for contiguous coverage. In order for ULYS to obtain the additional support outside the already existing gaps, heavy renegotiation with other missions is necessary.

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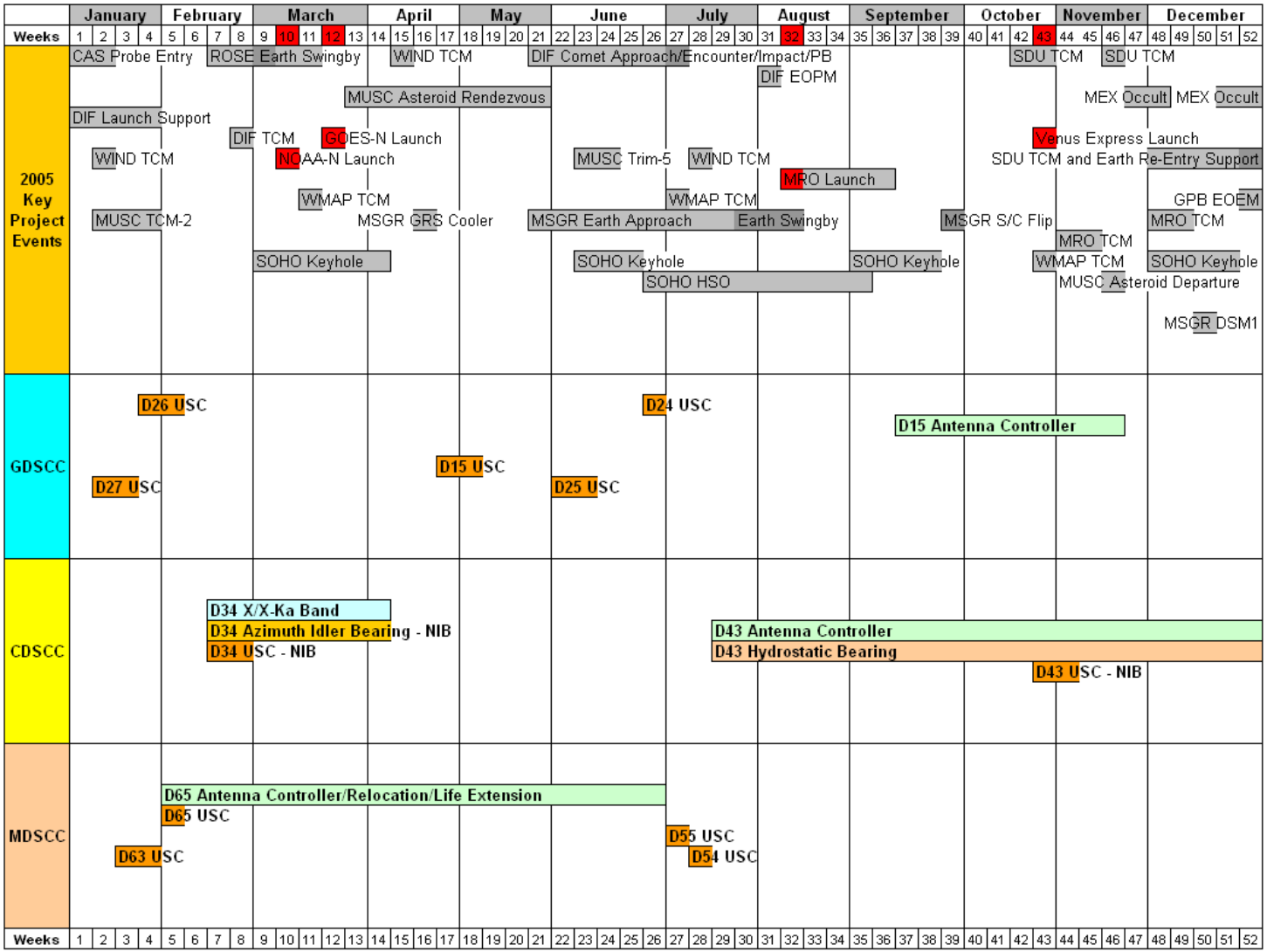
Supporting Data

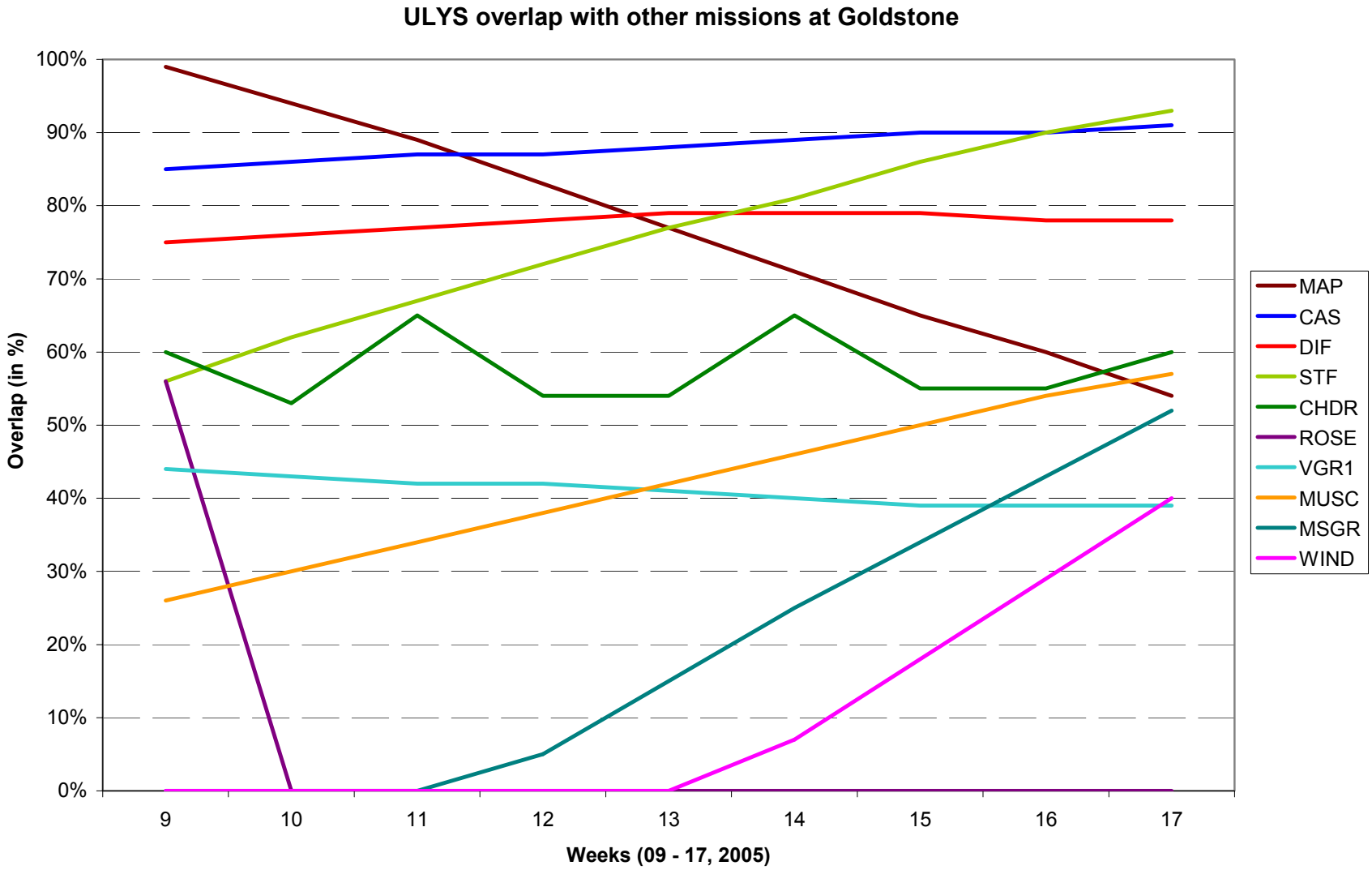
Gaps available in the Current Schedule Weeks 09 - 17

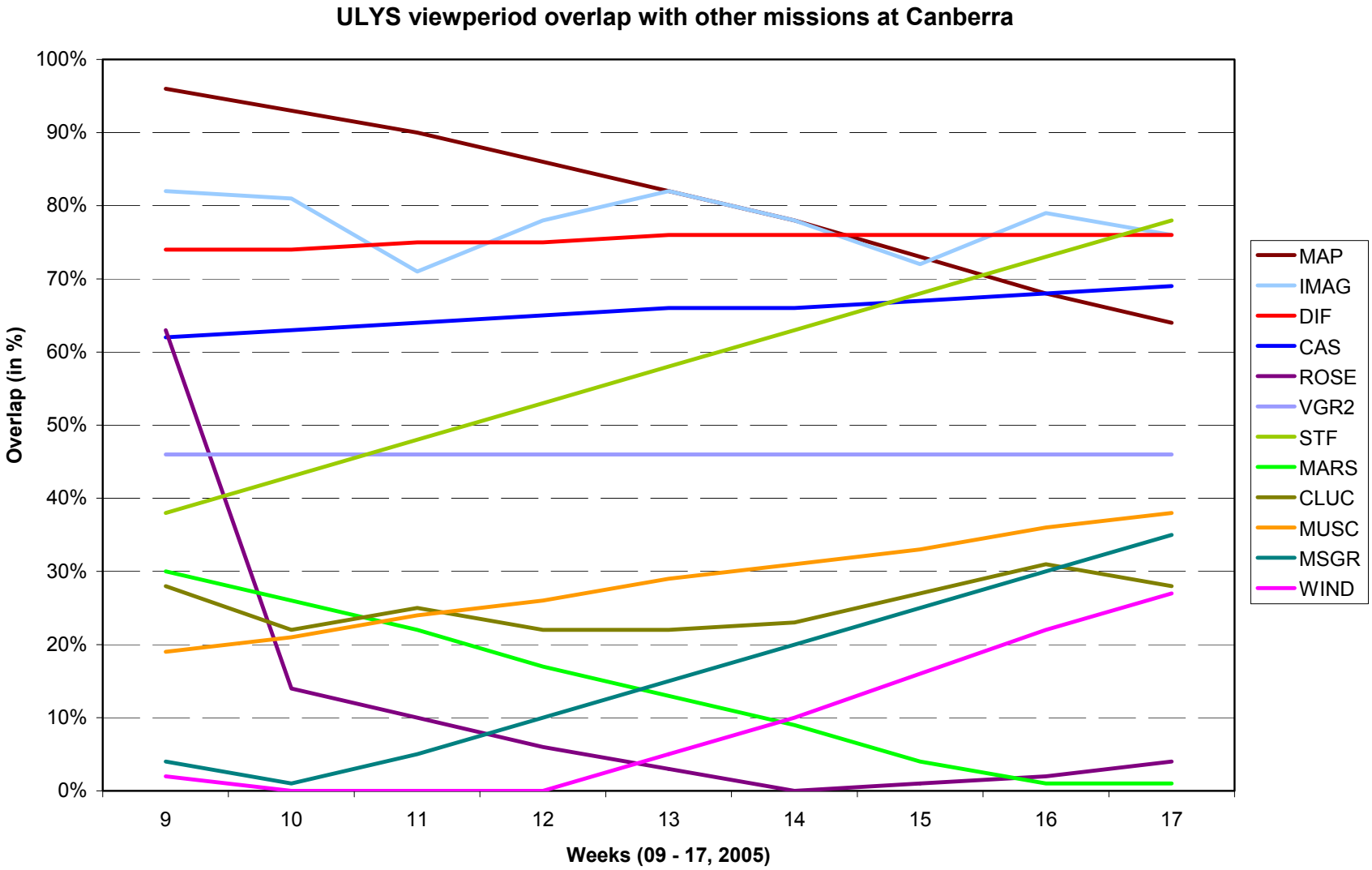
Antenna	Start Date	Start Time	End Date	End Time	Gap length (hrs)
DSS-55	2/28/05	21:30	3/1/05	3:15	5.75
DSS-55	3/2/05	18:50	3/3/05	3:15	8.42
DSS-55	3/3/05	19:50	3/4/05	3:15	7.42
DSS-45	3/5/05	9:00	3/5/05	17:05	8.08
DSS-54	3/5/05	20:45	3/6/05	3:10	6.42
DSS-63	3/7/05	21:00	3/8/05	2:55	5.92
DSS-55	3/8/05	21:55	3/9/05	3:25	5.50
DSS-45	3/10/05	10:15	3/10/05	15:35	5.33
DSS-54	3/10/05	20:45	3/11/05	2:30	5.75
DSS-54	3/12/05	21:00	3/13/05	3:15	6.25
DSS-63	3/13/05	17:56	3/13/05	23:25	5.48
DSS-24	3/14/05	2:20	3/14/05	9:05	6.75
DSS-55	3/16/05	21:45	3/17/05	2:55	5.17
DSS-55	3/18/05	19:50	3/19/05	3:40	7.83
DSS-25	3/19/05	5:20	3/19/05	11:25	6.08
DSS-54	3/19/05	20:20	3/20/05	2:45	6.42
DSS-55	3/20/05	20:20	3/21/05	2:55	6.58
DSS-63	3/21/05	17:30	3/21/05	23:35	6.08
DSS-24	3/22/05	4:00	3/22/05	11:11	7.18
DSS-54	3/22/05	17:13	3/23/05	2:30	9.28
DSS-54	3/23/05	21:30	3/24/05	2:30	5.00
DSS-24	3/25/05	4:45	3/25/05	10:00	5.25
DSS-43	3/27/05	6:09	3/27/05	11:45	5.60
DSS-63	3/27/05	21:25	3/28/05	2:25	5.00
DSS-54	3/31/05	19:35	4/1/05	2:00	6.42
DSS-15	4/2/05	1:43	4/2/05	9:50	8.12
DSS-63	4/2/05	16:19	4/2/05	22:05	5.77
DSS-55	4/5/05	19:45	4/6/05	2:17	6.53
DSS-63	4/7/05	15:56	4/7/05	21:45	5.82
DSS-54	4/8/05	19:20	4/9/05	1:25	6.08
DSS-25	4/9/05	23:11	4/10/05	7:00	7.82
DSS-54	4/10/05	15:43	4/11/05	0:00	8.28
DSS-26	4/11/05	23:02	4/12/05	6:55	7.88
DSS-54	4/12/05	19:40	4/13/05	1:00	5.33
DSS-55	4/13/05	20:40	4/14/05	1:42	5.03
DSS-25	4/15/05	22:44	4/16/05	5:30	6.77
DSS-26	4/17/05	22:35	4/18/05	6:35	8.00
DSS-14	4/20/05	22:22	4/21/05	4:25	6.05
DSS-24	4/21/05	22:17	4/22/05	5:00	6.72
DSS-55	4/22/05	19:30	4/23/05	1:03	5.55
DSS-26	4/23/05	22:09	4/24/05	6:15	8.10
DSS-14	4/25/05	23:00	4/26/05	4:15	5.25
DSS-24	4/27/05	2:45	4/27/05	8:33	5.80
DSS-26	4/27/05	21:51	4/28/05	8:29	10.63
DSS-34	4/28/05	9:00	4/28/05	15:06	6.10
DSS-55	4/30/05	19:05	5/1/05	0:30	5.42
				Total Gap Hours	**300.01**

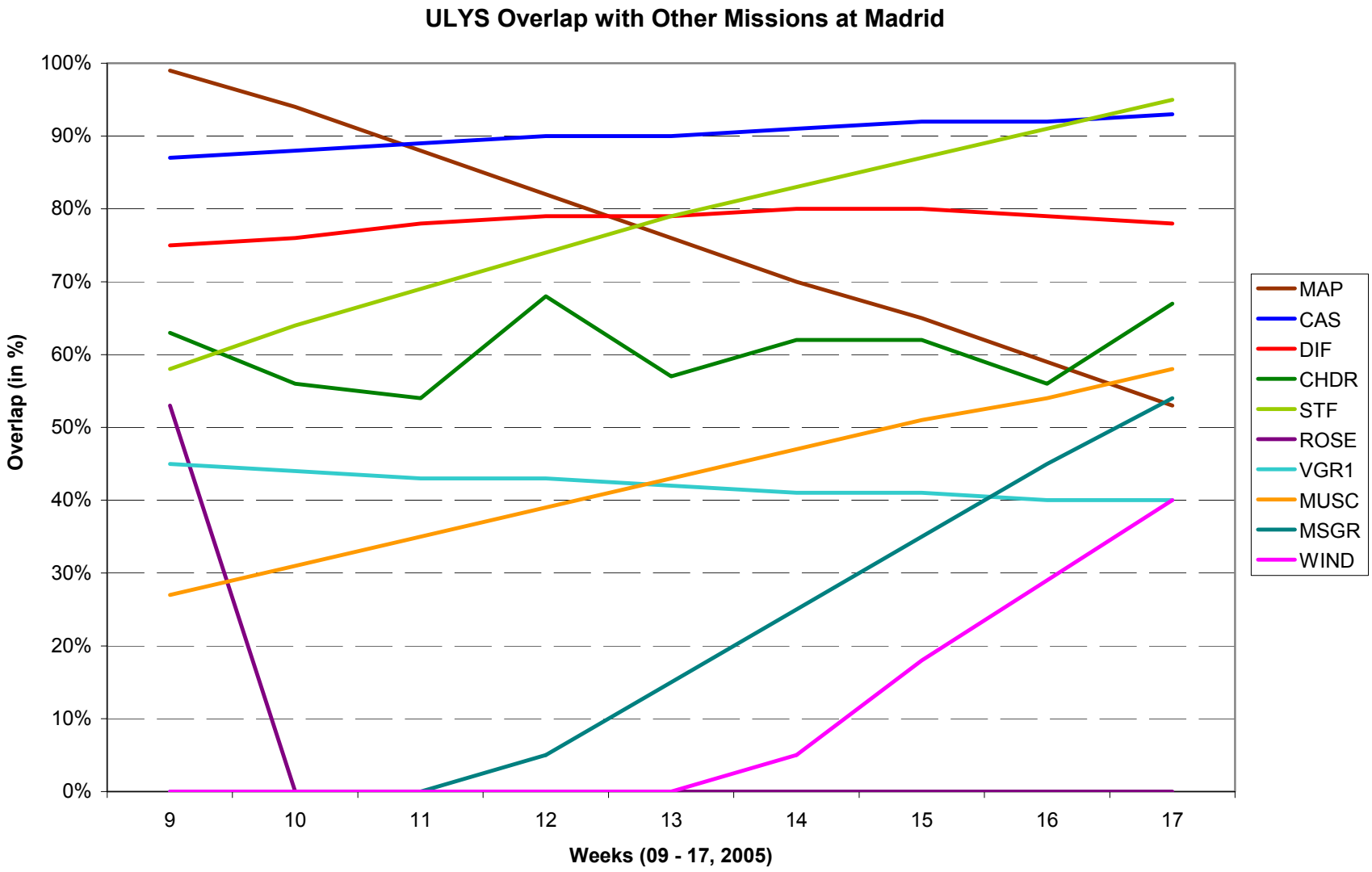
Major Events and Downtimes for 2005



Revised: November 18, 2004

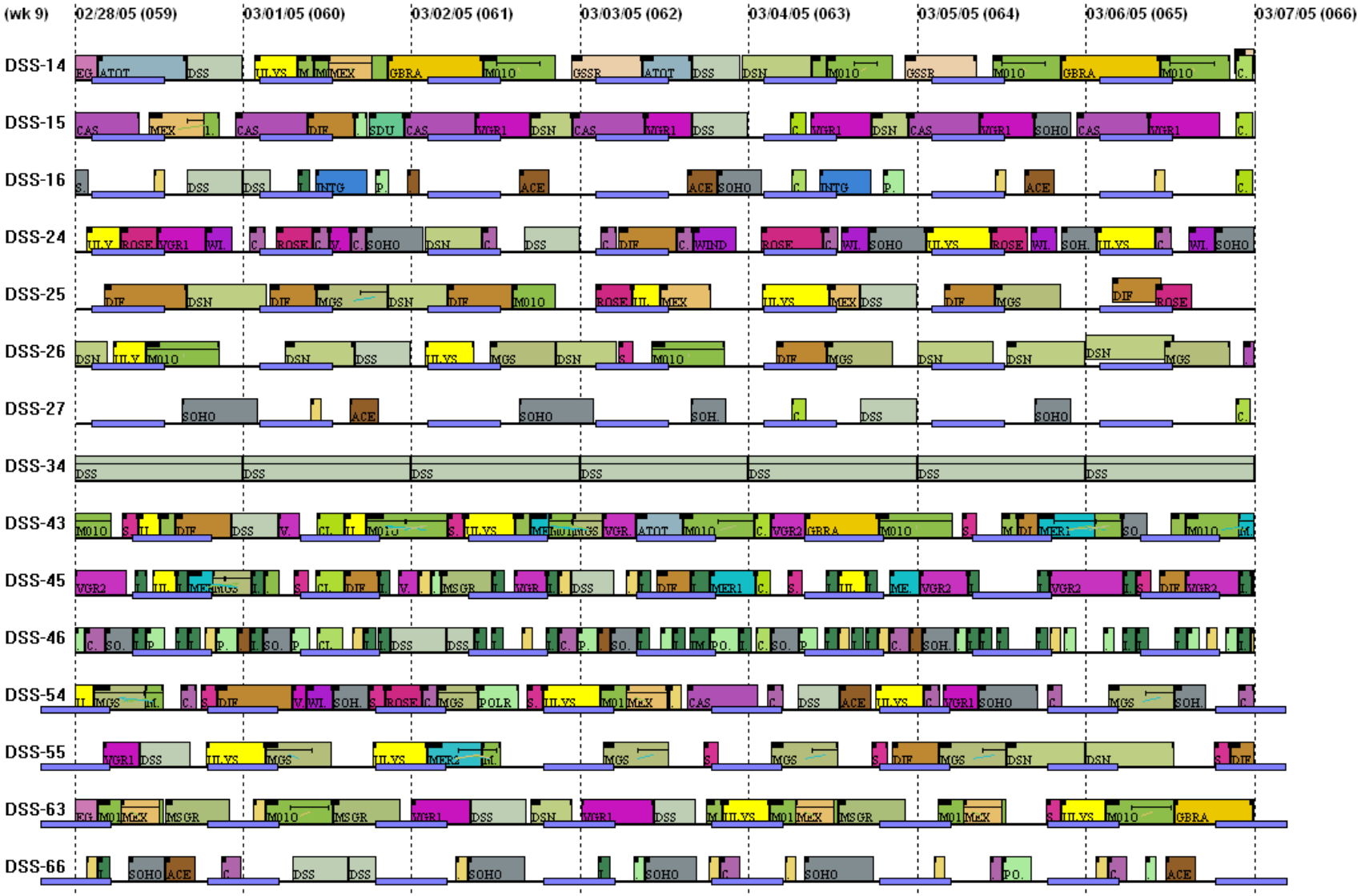

ULYS overlap with other missions at Goldstone
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
CAS
DIF
STF
CHDR
ROSE
VGR1
MUSC
MSGR
WIND


ULYS viewperiod overlap with other missions at Canberra
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
IMAG
DIF
CAS
ROSE
VGR2
STF
MARS
CLUC
MUSC
MSGR
WIND


ULYS Overlap with Other Missions at Madrid
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
CAS
DIF
CHDR
STF
ROSE
VGR1
MUSC
MSGR
WIND

Sample of a Current Schedule where ULYS is represented as ULYS

ULYS view period is represented as



Each color represents a specific mission.
Sample of a Schedule showing 18-hour coverage for ULYS